# Calibration procedures of radon instruments

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# Introduction

STANDARD

RADON CHAMBER

TRACEABILITY

UNCERTAINTIES

CALIBRATION RANGE

RADON SOURCE

ACCREDITATION

# Introduction

Calibration-

operation that, under specified conditions, in a first step, **establishes a relations** between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relations for obtaining a measurement result from an indication. (VIM, Guide 99:2010)

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# Introduction

In the 2016 call “metrology for environment” a consortium of 17 European institutes was granted a 3-year funding for a project named MetroRADON.

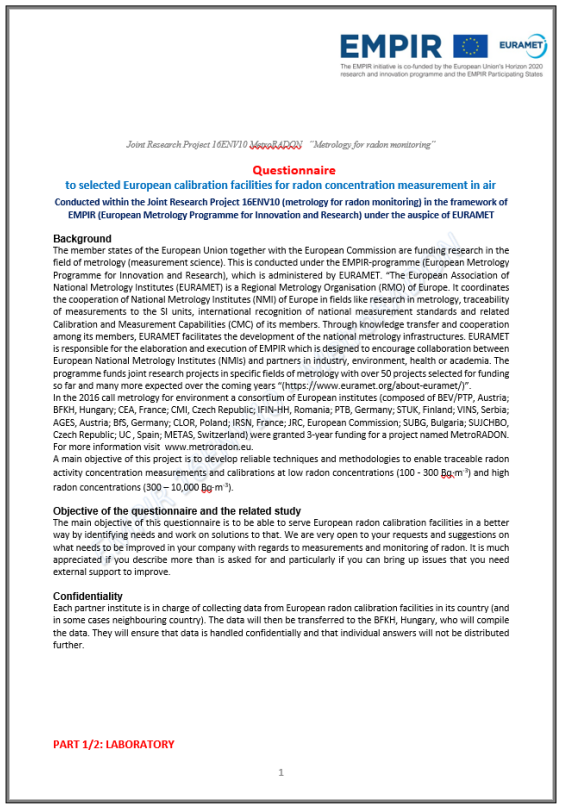
A main objective of this project is to develop reliable techniques and methodologies to enable SI traceable radon activity concentration measurements and calibrations at low radon concentrations (100 - 300 Bq $m^{-3}$) and high radon concentrations (300 – 10 000 Bq $m^{-3}$).

http://metroradon.eu/

# Introduction

Data from European radon calibration facilities was collected using a questionnaire.

The main objective of this questionnaire was to serve European radon calibration facilities in a better way by identifying needs and work to provide solutions to that effect.



EMPIR EURAMET

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

*Joint Research Project 16ENV10 MetroRADON "Metrology for radon monitoring"*

**Questionnaire**

**to selected European calibration facilities for radon concentration measurement in air**

**Conducted within the Joint Research Project 16ENV10 (metrology for radon monitoring) in the framework of EMPIR (European Metrology Programme for Innovation and Research) under the auspice of EURAMET**

**Background**

The member states of the European Union together with the European Commission are funding research in the field of metrology (measurement science). This is conducted under the EMPIR-programme (European Metrology Programme for Innovation and Research), which is administered by EURAMET. "The European Association of National Metrology Institutes (EURAMET) is a Regional Metrology Organisation (RMO) of Europe. It coordinates the cooperation of National Metrology Institutes (NMI) of Europe in fields like research in metrology, traceability of measurements to the SI units, international recognition of national measurement standards and related Calibration and Measurement Capabilities (CMC) of its members. Through knowledge transfer and cooperation among its members, EURAMET facilitates the development of the national metrology infrastructures. EURAMET is responsible for the elaboration and execution of EMPIR which is designed to encourage collaboration between European National Metrology Institutes (NMIs) and partners in industry, environment, health or academia. The programme funds joint research projects in specific fields of metrology with over 50 projects selected for funding so far and many more expected over the coming years "(https://www.euramet.org/about-euramet/)".

In the 2016 call metrology for environment a consortium of European institutes (composed of BEV/PTP, Austria; BFKH, Hungary; CEA, France; CMI, Czech Republic; IFIN-HH, Romania; PTB, Germany; STUK, Finland; VINS, Serbia; AGES, Austria; BfS, Germany; CLOR, Poland; IRSN, France; JRC, European Commission; SUBG, Bulgaria; SUJCHBO, Czech Republic; UC , Spain; METAS, Switzerland) were granted 3-year funding for a project named MetroRADON. For more information visit www.metroradon.eu.

A main objective of this project is to develop reliable techniques and methodologies to enable traceable radon activity concentration measurements and calibrations at low radon concentrations (100 - 300 Bq·m$^{-3}$) and high radon concentrations (300 – 10,000 Bq·m$^{-3}$).

**Objective of the questionnaire and the related study**

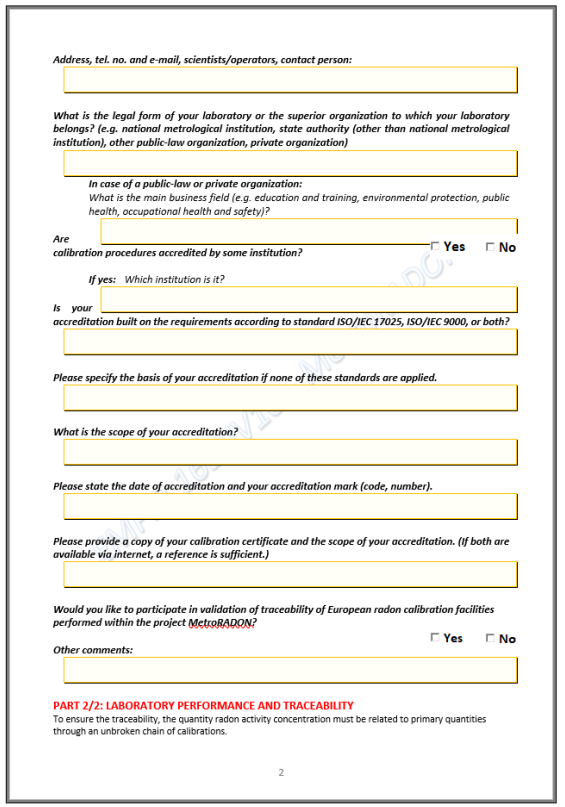
The main objective of this questionnaire is to be able to serve European radon calibration facilities in a better way by identifying needs and work on solutions to that. We are very open to your requests and suggestions on what needs to be improved in your company with regards to measurements and monitoring of radon. It is much appreciated if you describe more than is asked for and particularly if you can bring up issues that you need external support to improve.

**Confidentiality**

Each partner institute is in charge of collecting data from European radon calibration facilities in its country (and in some cases neighbouring country). The data will then be transferred to the BFKH, Hungary, who will compile the data. They will ensure that data is handled confidentially and that individual answers will not be distributed further.

**PART 1/2: LABORATORY**

1



***Address, tel. no. and e-mail, scientists/operators, contact person:***

***What is the legal form of your laboratory or the superior organization to which your laboratory belongs? (e.g. national metrological institution, state authority (other than national metrological institution), other public-law organization, private organization)***

***In case of a public-law or private organization:***
*What is the main business field (e.g. education and training, environmental protection, public health, occupational health and safety)?*

***Are calibration procedures accredited by some institution?*** ☐ Yes ☐ No

***If yes:*** *Which institution is it?*

***Is your accreditation built on the requirements according to standard ISO/IEC 17025, ISO/IEC 9000, or both?***

***Please specify the basis of your accreditation if none of these standards are applied.***

***What is the scope of your accreditation?***

***Please state the date of accreditation and your accreditation mark (code, number).***

***Please provide a copy of your calibration certificate and the scope of your accreditation. (If both are available via internet, a reference is sufficient.)***

***Would you like to participate in validation of traceability of European radon calibration facilities performed within the project MetroRADON?*** ☐ Yes ☐ No

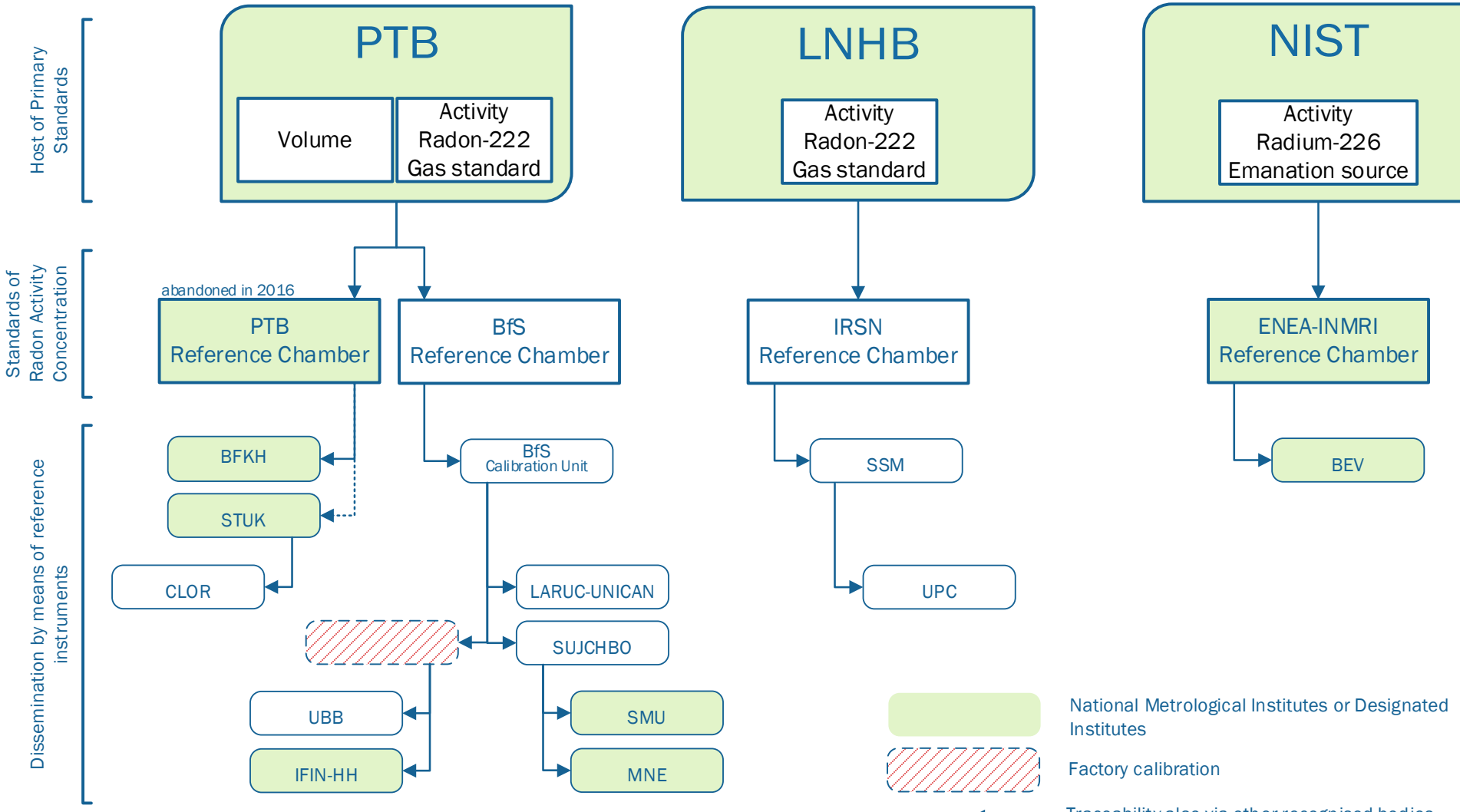
***Other comments:***

**PART 2/2: LABORATORY PERFORMANCE AND TRACEABILITY**

To ensure the traceability, the quantity radon activity concentration must be related to primary quantities through an unbroken chain of calibrations.

2

# Radon calibration facilities in Europe




Status 2018/2019

# Primary standard

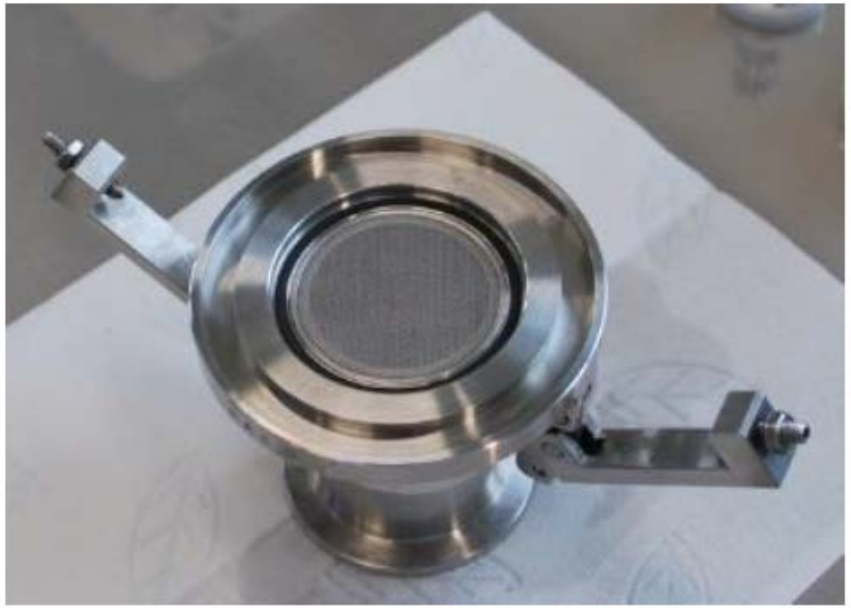
- Austria, BEV- suorce of traceability- PTB,
- China, NIM- suorce of traceability- NIM
- Czechia, CMI- suorce of traceability- CMI
- Germany, PTB- suorce of traceability- PTB
- Japan, NMIJ AIST- suorce of traceability- NMIJ AIST
- Korea, Republic of, KRISS- suorce of traceability- KRISS
- Ukraine NSC „Institute of Metrology”- NSC IM
- United Kingdom, NPL suorce of traceability- NIST
- United States, NIST suorce of traceability- NIST

https://www.bipm.org/kcdb/cmc/quick-search?keywords=Rn-222

Status 14.10.2020

# Radon sources

http://www.lnhb.fr/presentation-en/radon-measurement-facility/



Emanation source made by PTB Germany

# Radon sources


https://www.cmi.cz/sites/all/files/public/download/katalog_OI%20Praha_2015_english.pdf


https://pylonelectronics-radon.com/radioactive-sources/

# Reference standard

The following instruments represent the highest metrological level of radon activity concentration:

- **ten** participants use *AlphaGuard*s
- **two** institutes use liquid-scintillation counting (**LSC**) technique with radon standardization
- **one** participant uses a special **scintillation chamber** combined with a nuclear spectrometer and
- **one** organization reports using *Atmos 12DPX*.

# Radon chamber

## Should ensure (PN-EN-61577-4_2015-04E):

- equipment for producing the atmosphere,
- the equipment to containing the atmosphere,
- the reference atmosphere thus created
- the equipment methods for monitoring this atmosphere.

## Two main categories-

- Large containers (internal volume of several $m^3$) often designed as walk in with air-lock allowing entry and exit with the minimum disturbance
- Small containers only for the equipment under test.

# Radon chamber

- The minimum size of the reported equipment was 0.2 $m^3$ and the maximum size was 20 $m^3$
- Relative humidity
  - control in the range min value 10%, maximum value 95 %
  - monitoring in the range 0 – 90 %
- Temperature
  - control in the range min value from 20 °C, maximum value 60 °C
  - monitoring in the min value 10 °C, max value 35 °C
- Additional parameters:
  - the aerosol particle concentration,
  - size distribution,
  - the radon decay products concentration and fractionalization,
  - equilibrium factor of radium-radon
  - gamma-ray dose or dose rate.

# Calibration range

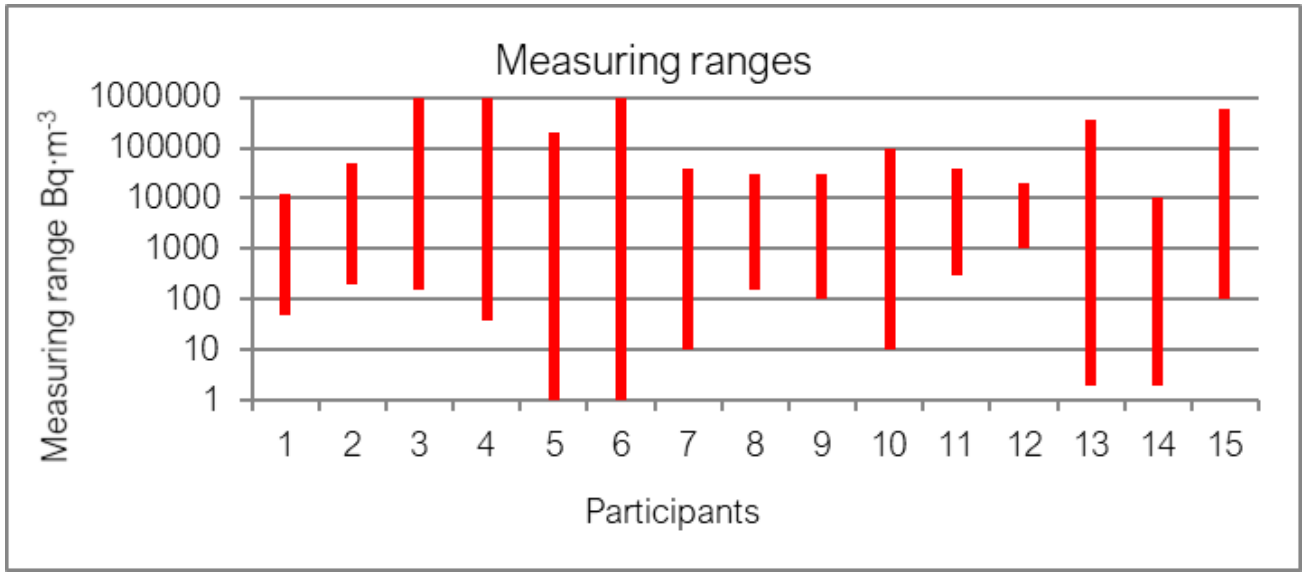
- radon in the environment can vary over five orders of magnitude*

- Implementation of Council Directive 96/29/Euratom cause the change in approach to calibration. New goal- development  of novel procedures for the traceable calibration of radon measurement instruments at low activity concentrations (100 Bq/m$^3$- 300 Bq/m$^3$ )

*Measurement of radon and radon progenies at the German radon reference chamber*, A. Paula, A. Honiga, S. Rottger, Uwe Keysera, Applied Radiation and Isotopes 52 (2000) 369-375

# Calibration range

Range from 1 Bq/m$^3$ to 1 MBq/m$^3$




Typical calibration ranges of individual institutes were two to three orders of magnitude. The participant covering the largest measurement range can measure **six orders of magnitude**, which can be reached by employing a combination of various measurement devices. Radon measurement below 10 Bq/m$^3$ is a challenge for most participants and it could be reached by three participants.

# Calibration range

**traceRadon**- new challenges- calibration below 100 Bq/m$^3$

To develop traceable methods for the measurement of outdoor low-level radon activity concentration in the range of 1 Bq m$^{-3}$ to 100 Bq m$^{-3}$, with uncertainties of 10 % for *k=1*, **to be used in climate monitoring and radiation protection networks**. These methods include two new traceable Rn-222 emanation sources below 100 Bq m$^{-3}$, a transfer instrument calibrated with these new sources to assure the traceability of the transfer instrument and a calibration procedure suitable to enable a traceable calibration of environmental atmospheric radon measurement systems in the field.

# Calibration range

new traceable, low level Rn-222 emanating sources (below 100 Bq $m^{-3}$)

↓

to develop a transfer standard for the traceable calibration of atmospheric radon monitors according to IEC 61577, at atmospheric radon levels (below 100 Bq $m^{-3}$)

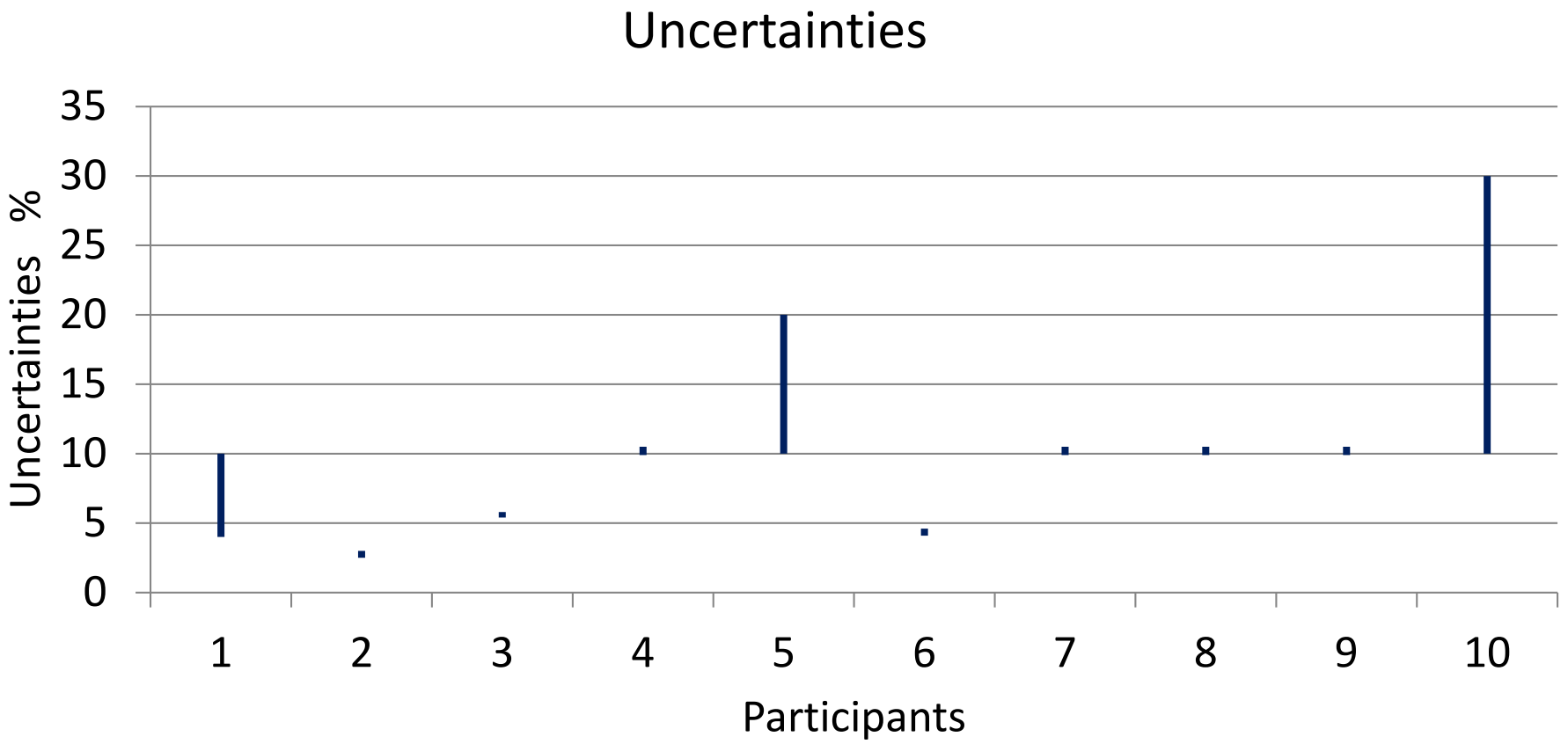
↓

to enable the traceable calibration of environmental atmospheric radon measurement systems in the field

# Uncertainties

Depends on:

- radon concentration,
- time,
- reference standard,
- traceability chain.



# Accreditation

Accreditation supports the market in facilitating the movement of goods and services where demand for quality and safety is growing. It offers a harmonized, transparent and sustainable approach which:

- helps fulfil legal requirements at reasonable costs
- enables innovation
- reduces the need for regulators to use their own resources
- builds consumers' and businesses' confidence.

Accreditation is the international stamp of approval that "tested once" means "accepted everywhere".

# Accreditation

- **ILAC MRA** (International Laboratory Accreditation Cooperation Mutual Recognition Arrangement)

  the aim of developing international cooperation for facilitating trade by promotion of the acceptance of accredited test and calibration results. The accreditation bodies that are signatories to the ILAC MRA for the relevant accreditation activities will accept the results of each other's accredited laboratories and inspection bodies, programs provided by PTPs and reference materials produced by RMPs.

# Thank you for your attention

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

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